CERES SSF Data and the Tropical Iris Feedback

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Introduction

- Lindzen, Chou and Hou (LCH, BAMS, 2001) proposed the existence of a Tropical Iris feedback strong enough to negate most warming effects.
- An active debate has since occurred.
- Criticisms of the Hypothesis focus on 2 aspects:
  1. Meaning of the observed cloud fraction vs SST trend (Hartmann and Michelsen, 2002)
  2. Values of the radiative properties for the model (Fu, Baker and Hartmann, 2002; Lin et al., 2002)

Observation (LCH)

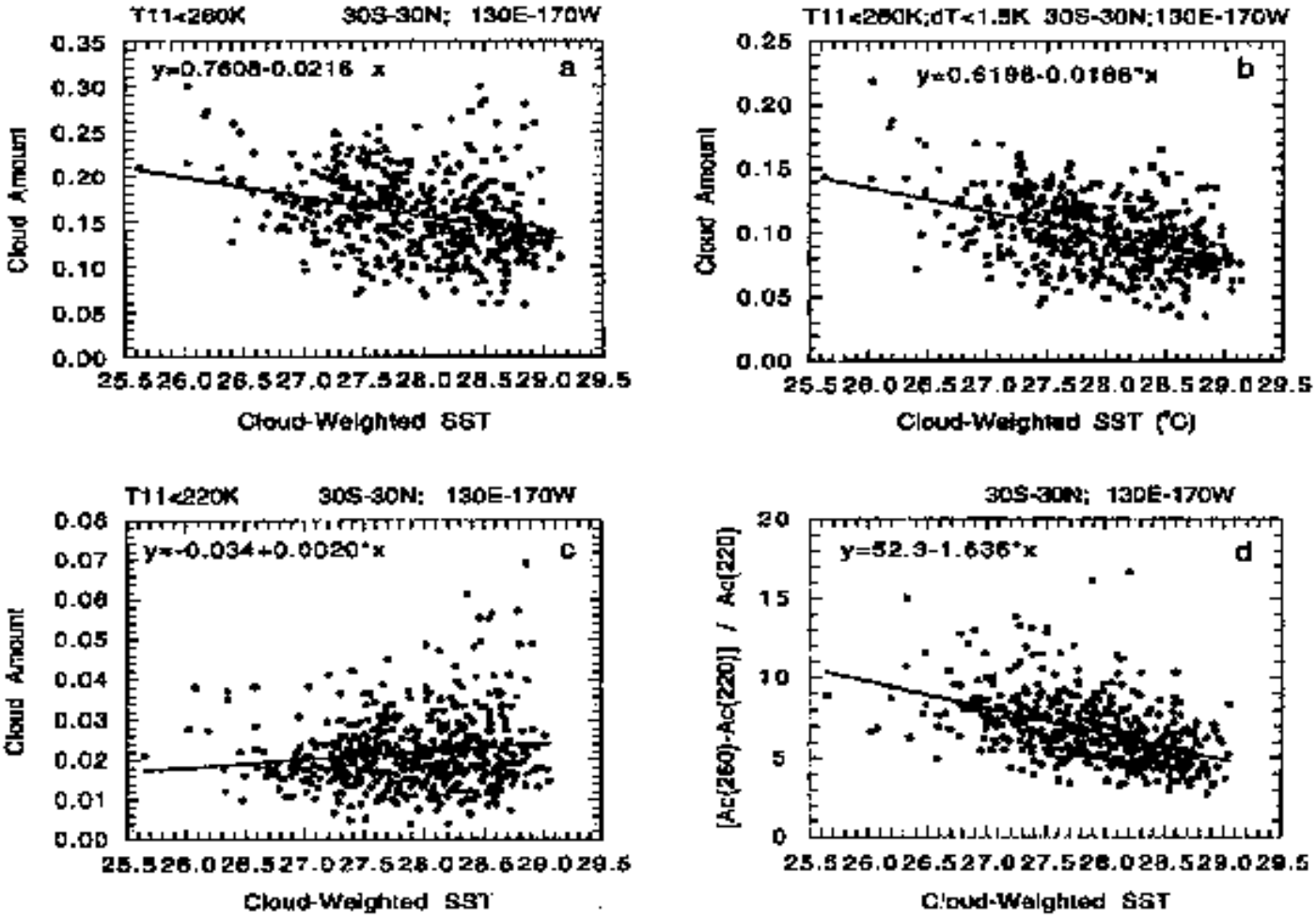
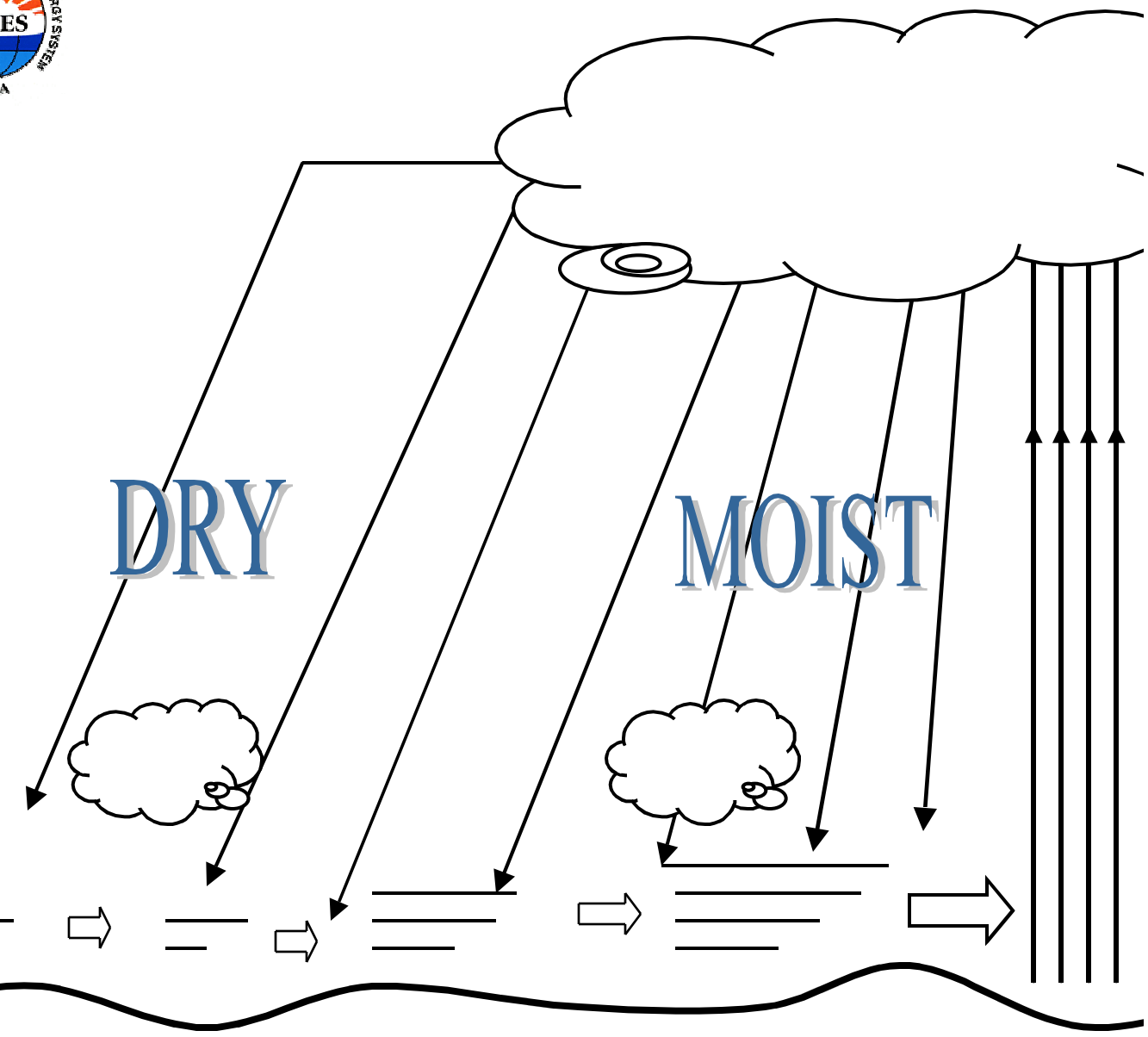
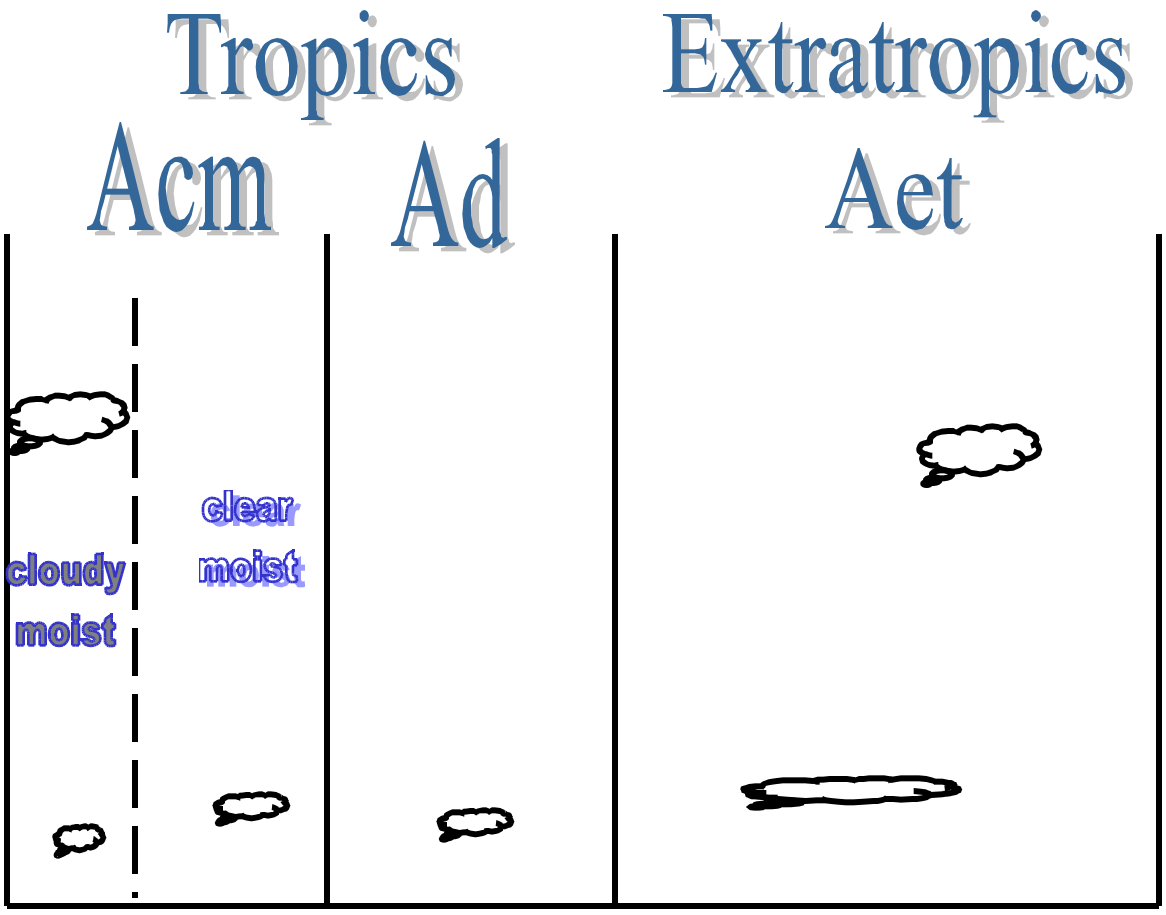


FIG. 5. Scatterplots showing how cirrus coverage varies with cloud-weighted SST for both "all" (a) upper-level clouds and (b) thick clouds. Also shown is (c) the variation of cumulus area with cloud-weighted SST and (d) the variation of cirrus coverage normalized by cumulus coverage. Data points correspond to daily averages. (See text for details.)



Atmospheric Moisturization



$T_{st} = T_s + 10K$ $T_{set} = T_s - 10K$

Objective

This study further addresses the radiative property aspect:

- CERES Single Scanner Footprint (SSF) data products from TRMM more objectively quantify the radiative properties

CERES Data

CERES/TRMM SSF Data:

- 5 precession cycles (Jan.-Aug., 1998)
- 3 ocean regions (30°S – 30°N)
- Tb (10.8μm)
- Cloud Properties (T_c, Phase)
- broadband LW & SW fluxes

Use of CERES Data

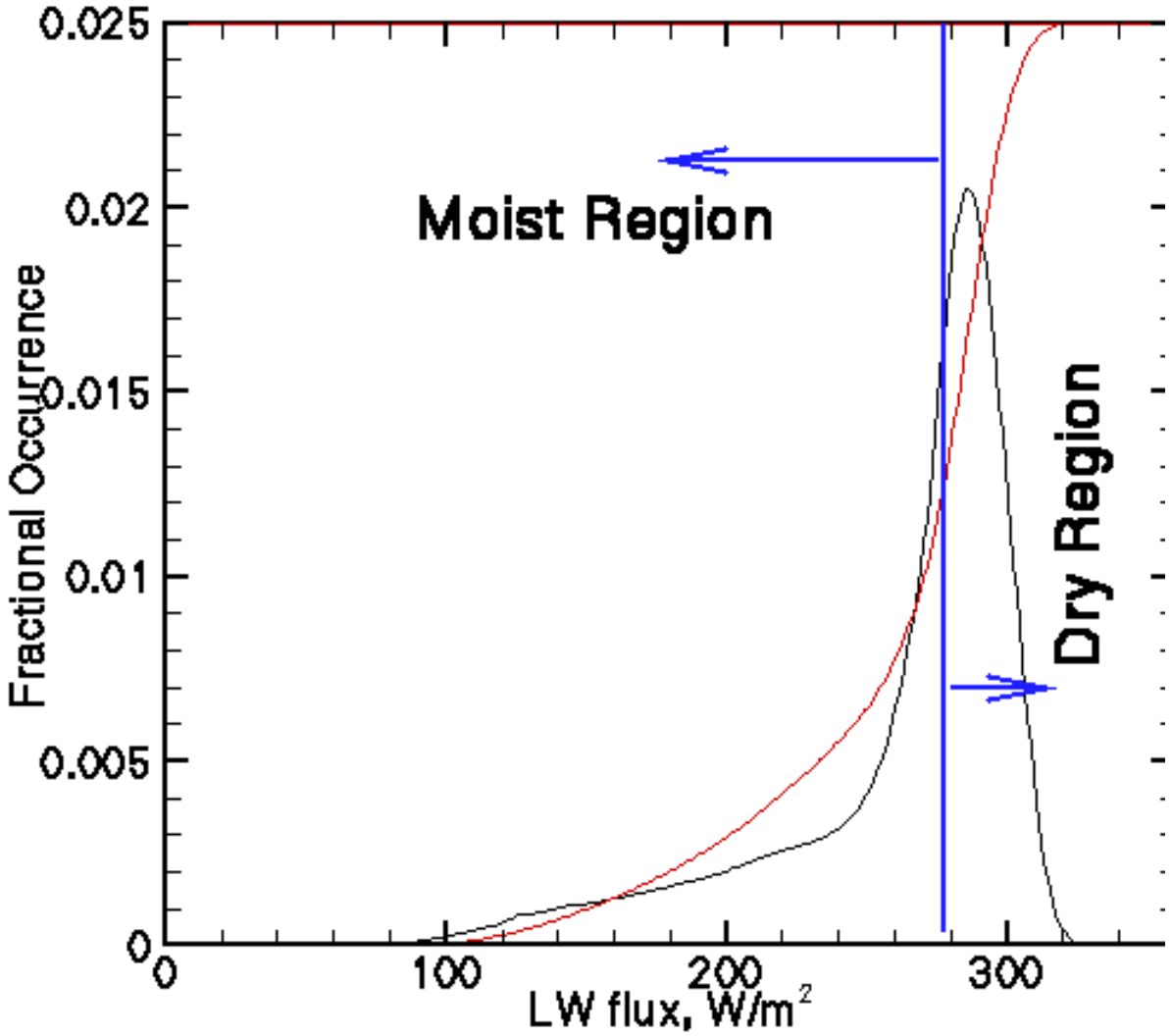
Definition of cloud & climate regimes:

- Dry region: broadband LW↑ > LW50
  (LW50: 50% percentile of 8-month LW↑)
- Cloudy moist: Various definitions
- Clear moist: all other pixels

Radiation Properties

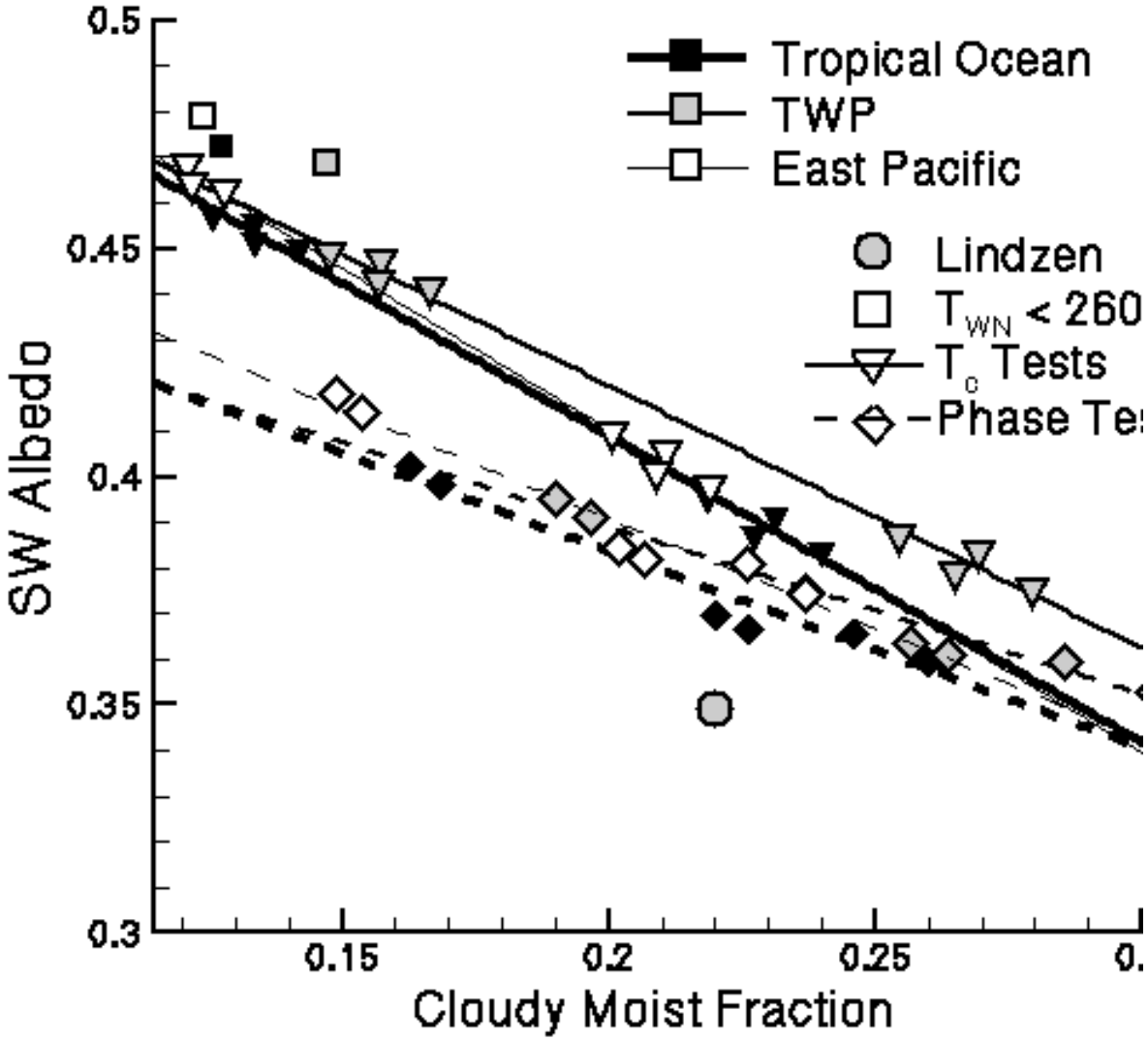
T_b Definitions

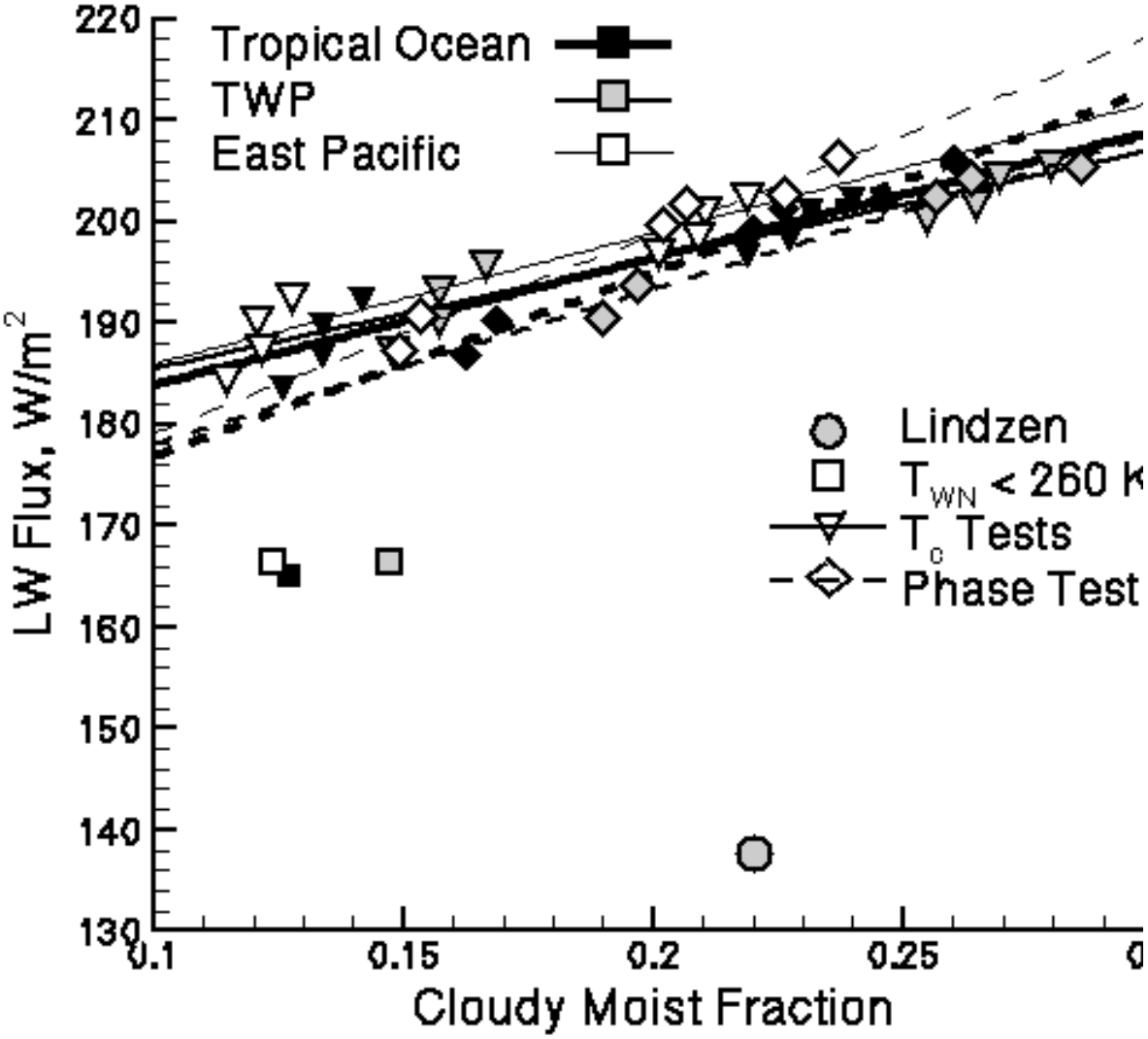
	LaRC – CERES			Lindzen et al.		
	Dry	Clear Moist	Cloudy Moist	Dry	Clear Moist	Clo Mo
equency of Occurrence	0.5	0.37	0.13	0.5	0.28	0.
Albedo	0.14	0.25	0.47	0.211	0.211	0.3
LW ↑	292	252	165	303.1	264.1	13
t ↓ Radiation	51.4	49.8	46.4	12.8	52.8	12
t net – dry net		-1.6	-5.0		40.0	11
oudy moist – clear moist			-3.4			70


0.025
0.02
0.015
0.01
0.005
0
Fractional Occurrence
Moist Region
Dry Region
0
100
200
300
LW flux, W/m2

16 New Cloudy Moist Def'ns

- Cloud temperature (T_c) based
  - $T_c < -15$ C
  - $T_c < -30$ C
- Cloud phase based (Ph = 1 for water, 2 for ice)
  - Ph > 1.5
  - Ph > 1.9
- Footprint mean
  - Any cloud fraction (A_c)
  - $A_c > 0.5$
- Extensive upper layer (more than half footprint)
  - Any A_c
  - $A_c > 0.5$


0.5
0.45
0.4
0.35
0.3
SW Albedo
0.15
0.2
0.25
0.
Cloudy Moist Fraction
Tropical Ocean
TWP
East Pacific
Lindzen
T_{WN} < 260
T_c Tests
Phase Te

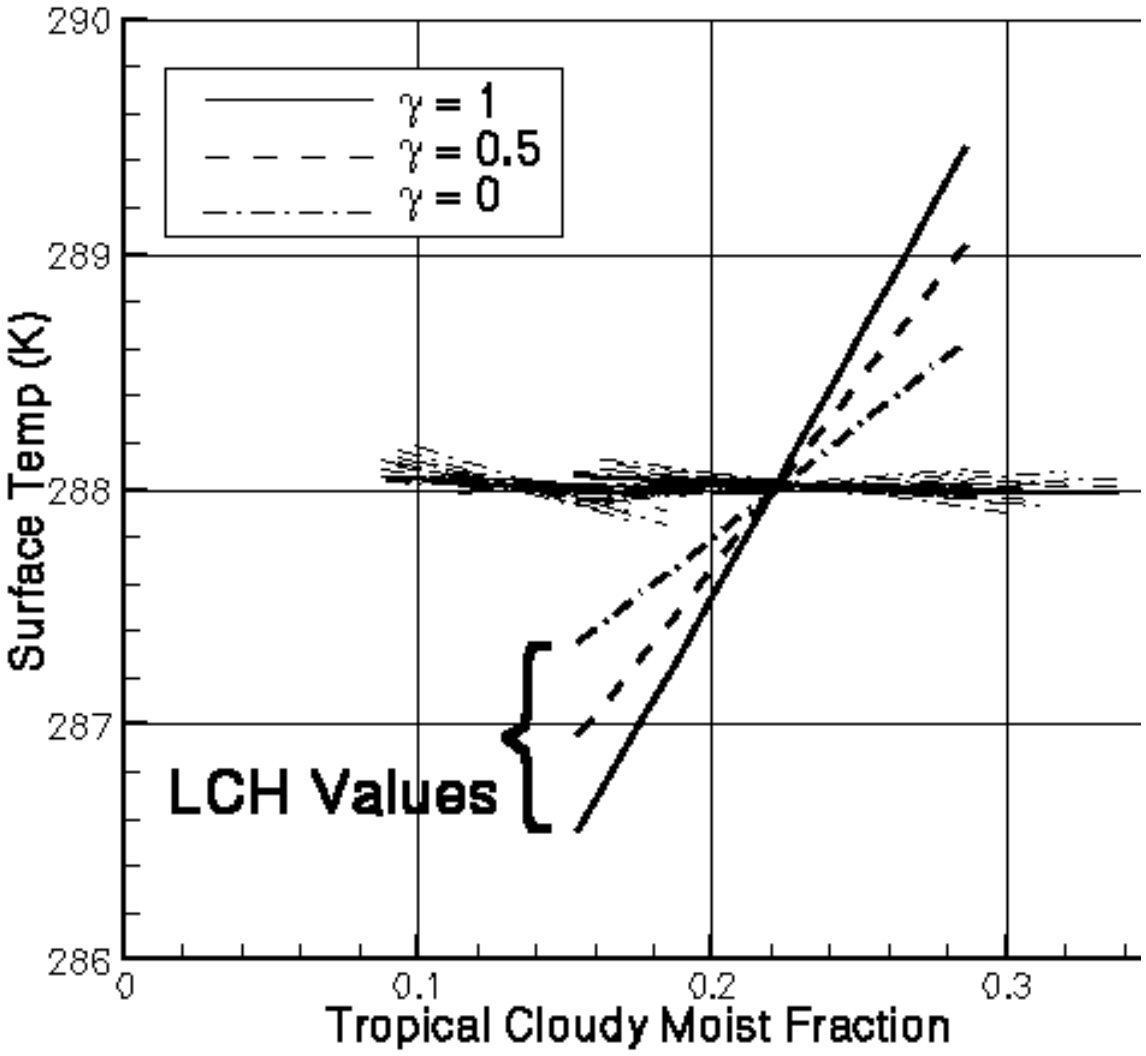

Tropical Ocean
TWP
East Pacific
Lindzen
T_{WN} < 260 K
T_c Tests
Phase Test
LW Flux, W/m^2
Cloudy Moist Fraction
220
210
200
190
180
170
160
150
140
130
0.1
0.15
0.2
0.25

3.5 Box Greenhouse Model

- Implement Lindzen's 3.5 Box Model
  - Use CERES cloud and radiation properties
  - Repeat with Lindzen values

$\gamma = 0$ cloudy moist changes as clear moist

$\gamma > 0 \rightarrow$ clear moist, cloudy moist, and dry region change, which produces stronger feedback.


290
289
288
287
286
Surface Temp (K)
γ = 1
γ = 0.5
γ = 0
LCH Values
0
0.1
0.2
0.3
Tropical Cloudy Moist Fraction

Conclusion

Using radiative properties determined from CERES SSF data in the 3.5-box greenhouse model calculations, we find that a decrease in anvil clouds with increasing SST results in a ***very small*** positive or negative feedback compared to the strong negative feedback of Lindzen et al.

For more information:

Chambers, L. H., B. Lin, D. F. Young, “New CERES data examined for evidence of Tropical Iris feedback", Journal of Climate, in review, 2002.

Future Efforts

- Use CERES TISA products to examine the relation between cloudy moist area and SST
- Use a cloud object approach to locate the Hadley cell without contamination from sub-tropical storm tracks

Both approaches enabled by EOS era data product: the CERES SSF